Effective Improvement of Pilot Airplane State Awareness
Avoiding Loss of Control In-flight (LOC-I)

Paul BJ Ransbury, President
apstraining.com
Thank you for the Opportunity

Paul BJ Ransbury, President – Aviation Performance Solutions

- 20th Year Full-Time Development & Delivery of Upset Prevention & Recovery Training (UPRT)
- 1000s of Professional Pilots Trained
- APS Global Network: USA | Europe | Middle East

- NBAA Safety Committee
  - Team Lead: Loss of Control In-flight (LOC-I) Working Group
- Former Airline Pilot / Military Pilot
- 5 x Master CFI / Fighter Weapons Instructor
- 4,500+ Upset Recovery Flights Hours (Piston & Jet Aircraft)
- B.Sc. Physics – Royal Military College of Canada, MBA (finishing)
1. Understanding **Loss of Control In-Flight (LOC-I)**  
   Statistics, terms and definitions.

2. **Airplane State Awareness**  
   Overview of the main LOC-I efforts underway and resources available.

3. **Global Perspective**  
   Looking at LOC-I from the highest level.

4. **Hazardous Attitudes**  
   Can enable distraction, complacency and loss of situational awareness.

5. **Snapping Out of It**  
   Surviving a Loss of Control In-flight event.
What is LOC-I?

- LOC-I = Loss of Control In-flight
  - An extreme manifestation of a deviation from intended flight path (ICAO, CAST, EASA)
  - An adverse flight condition placing an airplane outside of the normal flight envelope with an inability of the pilot to control the airplane (Media)
  - Quantitative Loss of Control Criteria (NASA, Boeing)
    - Multiple Envelopes: flight dynamics, aerodynamics, structural integrity and flight control use
Loss of Control In-flight (LOC-I) is Old News – It’s Much Better Now, Right?

Up ↑ 8.5% Over Same 2014 Report
Greater Than ↑ Next Category by 100+%
Top 3 Safety Priorities

Percentage of All Accidents: 2006-2013

- Controlled flight into terrain
- Runway Safety related
- Loss of control in-flight

*Accidents involving scheduled commercial air transport with maximum take-off weight exceeding 5 700 kg*
Airplane Upset Defined
Precursor to Loss of Control In-flight

While specific values may vary among airplane models, the following generally describes an upset for jet aircraft:

- **Pitch**: Greater than 25° nose up
- **Pitch**: Greater than 10° nose down
- **Bank**: Greater than 45°
- **Within above parameters, but flying at airspeeds inappropriate for conditions.**
- **Unintentional**
- **Is a Stall an Airplane Upset?**
- **Airplane State Awareness?**

*As defined by the Airplane Upset Recovery Training Aid – Revision 2*
LOC-I Causes and Mitigations

- **Pilot Induced**
  - Distraction, etc.

- **System Anomaly-Induced**
  - Flight Control Failure, etc.

- **Environmentally Induced**
  - Wake Turbulence, etc.
Video: Loss of Control In-Flight

Why We Must Be Concerned
ANA Flight 140 – Rudder Trim

737-700
(Incident Aircraft)

737-500
(First Officer’s Previous Airplane)
Distraction Management

Distraction management integrated with enhanced awareness keeps us focused on what matters when it matters most.
LOC-I Escalation Spectrum

**Awareness**
- Environmental
- Turbulence
- Wake Turbulence
- Airplane Icing
- System Anomalies
- Flight Instruments
- Autoflight Systems
- Flight Controls
- Pilot-Induced
- Crosscheck
- Attitude and Power
- Inattention
- Distraction
- Incapacitation
- Automation Use
- Techniques
- Monitoring
- CRM
- Startle / Surprise
- Combinations
- Aerodynamic Stall

**Prevention**
- Knowledge
- Planning
- Currency
- Aeronautical Decision Making
- Risk Management
- Distraction
- Threat and Error Management
- Intervention
- Recognition

**Recovery**
- Airplane Upset
- Loss of Airplane State Awareness
- True Loss of Control In-flight

Escalation of the LOC-I Threat

CRASH
Airplane State Awareness

Yesterday, Today and Tomorrow
High-level LOC-I Landscape
Unprecedented Advancements in LOC-I Underway

- **ICAO UPRT**
  Manual on Aeroplane Upset Prevention & Recovery Training

- **FAA**
  AC 120-109 Stall
  AC 120-111 UPRT

- **EASA**
  Mandates: Upset Prevention & Recovery Training

- **IATA UPRT**
  Best Practices in Implementing UPRT

- **GAJSC**
  GAJSC SEs
  Loss of Control In-flight ~ 30 Safety Enhancements

- **CAST SEs**
  Airplane State Awareness 19 Safety Enhancements
Airplane State Awareness

ASA Joint Safety Implementation Team

Airbus
ALPA Intl
Airlines for America
Austin Digital, Inc.
Boeing Company
Bombardier Aerospace
FAA
Honeywell
NASA
MITRE Corporation
United States Air Force
Wyle
Airplane State Awareness

• Definition of Awareness*
  – Knowledge that something exists, or understanding of a situation or subject at the present time based on information or experience.

* Cambridge English Dictionary
Where Are We Vulnerable?
You, Your Attitude and Your Aircraft

100% All-Attitude Environment

90° nose up

11% Training Stops

5% Core Skills

90° nose down

180° roll left

180° roll right
Note: L/D max, also known as minimum drag speed (V_{md}), separates the speed range of normal flight (green region) from slow flight, often called the back side of the power-drag curve or the region of reverse command.
Airplane State Awareness

• 18 Accidents / Incidents: 1998 to 2010
• LOC-I where crew lost awareness of their airplane’s state:
  – Attitude (pitch, bank angle or rate), or
  – Energy (combination of airspeed, altitude, vertical speed, thrust, and airplane configuration)
  – Majority of All LOC-I over Previous 10 Years
• Identified 274 Intervention Strategies (IS) in 2014
  – 181 Previously Documented
  – 93 Newly Developed
• Identified 12 Major Themes
Airplane **State** Awareness – **Categories and Themes**

**Flightcrew Training**
- 100% Distraction
- 89% CRM
- 78% Automation Confusion and/or Awareness
- 67% Inappropriate Control Inputs
- 50% Training
- 39% Flightcrew Impairment
- 39% Systems Knowledge

**Design, Ops, Data, Research**
- 100% Ineffective Alerting
- 94% Lack of External Visual References
- 67% Safety Culture
- 33% Airplane Maintenance
- 28% Invalid Source Data
### Distribution of Strategies by Categories

#### Key
- **P** = primary means of mitigation
- **s** = secondary means of mitigation
- **-** = none

#### Table

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## Summary of ASA Safety Enhancements

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<th>SE</th>
<th>Title</th>
<th>% Risk Reduction</th>
<th>Implementers / Costs ($M)</th>
<th>Flow (mos.)</th>
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<td>Air Carriers</td>
<td>Manufacturers</td>
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<td>192</td>
<td>Low Airspeed Alerting</td>
<td>9.6%</td>
<td>$0.3</td>
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<td>193</td>
<td>Non-standard Operations</td>
<td>3.9%</td>
<td>$4.1</td>
<td>$0.5</td>
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<td>194</td>
<td>SOP Adherence</td>
<td>21.4%</td>
<td>$18.5</td>
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<td>Training Verification &amp; Validation</td>
<td>10.1%</td>
<td>$4.0</td>
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<td>196</td>
<td>Upset Prevention and Recovery Training, Including Stall</td>
<td>17.1%</td>
<td>$3.1</td>
<td>$4.4</td>
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<td>197</td>
<td>Policy and Training for Non-normal situations</td>
<td>10.9%</td>
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<td>Scenario-Based Training for Go-Arounds</td>
<td>12.7%</td>
<td>$0.8</td>
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<td>Enhanced CRM Training</td>
<td>28.2%</td>
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<td>Virtual Day-VMC Displays</td>
<td>16.0%</td>
<td>$0.3</td>
<td>$17.9¹</td>
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<td>Bank Alerting with Recovery Guidance</td>
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<td>$6.1²</td>
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<td>Bank Angle Protection</td>
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<td>$2.1³</td>
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<td>Totals</td>
<td>72.6%</td>
<td>$43.0</td>
<td>$30.7</td>
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¹ for 2035 fleet implementation  
² for 2 programs  
³ for 1 program
LOC-I Accident Model

- Awareness Prevention
- Point of Destabilization
- Skill Exceeded
- Crash
Global Perspective

Looking at LOC-I from the highest level.
Escalation of Transferable Skills

IOS Enhancements

Core Skills: On-aircraft UPRT – CPL / MPL
- All-envelope All-attitude Platform Recommended
- Repetition to Proficiency: Transferrable & Positive
- Startle, Fear, Reality – Factors
- Industry-approved Techniques

UPRT-specific Academics
- Industry-approved
- Airplane Upset Recovery Training aid

Simulator: Type-specific UPRT
- Type & Recurrent: AC 120-111

Simulator: Non-type-specific UPRT
- Similar Concept: ATP CTP – Aug 2014
Global Perspective

ICAO Manual on Aeroplane Upset Prevention & Recovery Training

Aerodynamics
- Situation Awareness
  - Human Information Processing
  - Inattention and Fixation
  - Distraction
  - Perceptual Illusions
  - Spatial Disorientation
  - Instrument Interpretation

Startle and Stress Response
- Psycho-physiological Response
- Cognitive Effects
- Management Strategies

Human Factors

Threat & Error Management
- TEM Framework
- Active Monitoring / Checking
- Fatigue Management
- Workload
- CRM

May 6, 2016
Business Aviation Safety Summit 2016
Influence of hazardous mental attitudes concerning airplane state awareness during routine flight operations leading to unintended consequences.
Video: Invulnerability
Hazardous

Macho?
Anti-authority?
Resignation?
Impulsivity?
Invulnerability?
Vulnerabilities to LOC-I
Hazardous Mental Attitudes

100% All-Attitude Environment
5% Core Skills
11% Training Stops

Attitude Upset
Dolor sitamet, consectetur adipisicing eli. Dolor sitamet,

Stall Upset
Dolor sitamet, consectetur adipisicing eli. Dolor sitamet,
Defeating **LOC-I** – A **Mental** Attitude

Positive Aircraft Control
Faster Than L/D Max Speed
Less Than
45 Bank Angle
25 Nose Up / 10 Nose Down
Regaining situational awareness, positive flight path control and task prioritization can be learned systematically even in a time-critical life-threatening crisis.
How the Brain Works Under Threat
Your Brain as an Aircraft System
Amygdala: What?

- Sensory Thalamus
- Sensory Cortexes
- Amygdala
- Hippocampus

LONG ROUTE
- Concept
- Context
- characteristics

SHORT ROUTE
- Emotional Stimulus
- Emotional Response

May 6, 2016
Business Aviation Safety Summit 2016
It’s a Snake!

No, it’s not.
Applications to LOC-I Training

- Habituation
  You get used to things (exposure inadequate)

- Sensitization
  May get worse before it gets better

- Extinction
  Overlaying new experience (retire fears)

- Reappraisal
  Change the interpretation (counter-intuitive factors)

- Overlearning
  Automatized response
LOC-I Strategy Toolkit

• Stop
• Push
• Roll
• Stabilize

• Stall: In Training (controlled) | Real World (complex)
• Attitude Upsets: Nose Low | Nose High | High Bank
• Combinations and Alternate Strategies
• Upset Prevention: By Axis (Pitch, Roll, Yaw) | By Parameters (Speed)
Effective Improvement of Pilot Airplane State Awareness
Avoiding Loss of Control In-flight (LOC-I)

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